SUBSTITUTE SPECIFICATION

ELECTROMECHANICAL SWITCH

[0001] This application is the national phase under 35 U.S.C. § 371 of PCT International Application No. PCT/EP2004/002618 which has an International filing date of March 12, 2004, which designated the United States of America and which claims priority on German Patent Application number DE 103 15 243.1 filed April 3, 2003, the entire contents of which are hereby incorporated herein by reference.

Field of the Invention

[0002] The invention generally relates to an electromechanical switching device. In particular, it relates to a capacitor contactor.

Background of the Invention

[0003] A switching device is known, for example, from DE 31 05 117 C2. The switching device known from DE 31 05 117 C2 has main contacts and leading contacts, also referred to as auxiliary contacts, which are interconnected with series damping resistors given a capacitive load.

[0004] The same also applies, for example, to a capacitor contactor known from DE 197 29 595 C1. When the switching device or capacitor contactor is switched on, initially the auxiliary contacts close such that a connected capacitor is initially pre-charged via the series damping resistors. This weakens the switch-on current peak when the main contacts close.

[0005] When the switching device is switched off, initially the main contacts open and thus disconnect such that there is virtually no current. Overall, switch-on arcs thus predominantly occur at the main contacts. Since such switch-on arcs lead to changes in the contact pieces, the risk of wear is increased. Furthermore, when the switching device is switched off, a relatively long arc-burning period results at the main contacts, which form a zero-current interrupter, as a result of which the life of the device is shortened.

[0006] In order to counteract these disadvantages, the actuation of the main contacts could be decoupled from the actuation of the auxiliary contacts. This would, however, require the switching mechanism to have a relatively complex design.

SUMMARY OF THE INVENTION

[0007] An embodiment of the invention includes an object of specifying an electromechanical, in particular electromagnetic, switching device having a main contact and an auxiliary contact which leads during the switch-on process, in particular for the purpose of reducing a switch-on current peak.

[0008] The switching device of an embodiment can include a simple design and particularly low wear owing to arcs on the main and/or auxiliary contact.

[0009] This switching device of one embodiment has a main contact which includes a number of, generally two, main fixed contacts and a moveable main contact bridge which can be connected to said main fixed contacts. In addition, the switching device has an auxiliary contact which closes early during the switch-on process and

which analogously comprises a number of auxiliary fixed contacts and a moveable auxiliary contact bridge which can be connected to said auxiliary fixed contacts.

[0010] For the purpose of actuating both the main contact and the auxiliary contact, a contact bridge holder or carrier is provided which is mechanically connected to the two contact bridges. At least one of the contact parts (main fixed contact, main contact bridge, auxiliary fixed contact and auxiliary contact bridge) is mounted in a sprung manner.

[0011] The auxiliary contact bridge or the at least one auxiliary fixed contact may assume two stable positions which are defined, in the case of the bistable auxiliary contact bridge, relative to the contact bridge holder and, in the case of the bistable auxiliary fixed contact, relative to a rigid structure of the switching device. As the switching device is switched on, the auxiliary contact bridge or the auxiliary fixed contact is in the first position when the auxiliary contact closes and thus ensures the leading switching behavior of the auxiliary contact in relation to the main contact.

[0012] When the switching device is switched off, the auxiliary contact bridge or the auxiliary fixed contact is in the second stable position at least at the point in time at which the auxiliary contact opens. This also results in a leading switching behavior of the auxiliary contact during the switch-off process, i.e. the auxiliary contact opens before the main contact. The changeover between the first and the second stable position of the auxiliary contact bridge or the auxiliary fixed contact or the auxiliary fixed contacts takes place with the actuation of the contact bridge carrier.

[0013] In one embodiment of the switching device which can be implemented simply in design terms, the switching device is designed such that the auxiliary contact bridge can be electrically connected to the auxiliary fixed contacts when the contact bridge holder is actuated only in the first position of the auxiliary contact bridge or the auxiliary fixed contact. Whereas, in the second position of the auxiliary contact bridge or the auxiliary fixed contact, the auxiliary contact bridge is always separated from the auxiliary fixed contacts irrespective of the position of the contact bridge carrier.

[0014] When the electromechanical switching device is switched on, in accordance with a preferred refinement the auxiliary contact bridge or the auxiliary fixed contact is moved over from the first position to the second position by the contact bridge carrier being actuated once the main contact has closed, it is thus possible for the auxiliary contact to be open following completion of the switch-on process. During the switch-off process, the auxiliary contact bridge or the auxiliary fixed contact is thus initially in the second position. However, during the switch-off process, the auxiliary contact bridge or the auxiliary fixed contact, in turn triggered by the displacement of the contact bridge holder, by interacting with a stop provided for this purpose only changes to the first position once the main contact has opened.

[0015] Owing to the changeover of the auxiliary contact bridge or the auxiliary fixed contact during the switch-off process, the auxiliary contact is not closed again. The auxiliary contact thus remains out of operation throughout the switch-off process.

[0016] As a result of the fact that during the switch-off process only the main contact switches, an arc across the main contact typically occurs not only during the switch-on process but also during the switch-off process. In addition to protecting the auxiliary contacts, this has the advantage that any softened contact mass present on the main contact and formed by the switch-on arc melts over again, as a result of which there is a reduced risk of wear and thus the life of the switching device is lengthened. A simple design for the switching device is achieved by both the main contact bridge and the auxiliary contact bridge remaining coupled to the contact bridge holder during all switching processes.

[0017] A space-saving design for the switching device is preferably implemented by the main contact bridge and the auxiliary contact bridge being arranged at least approximately parallel to one another. The contact bridge holder is preferably arranged perpendicular to one of the contact bridges, in particular to the two contact bridges. In a manner known per se, the contact bridge is furthermore preferably mounted in a sprung manner in the contact bridge carrier, in particular using a spring arranged within the cross section of the contact bridge carrier. The design of the switching device in this regard largely corresponds in terms of embodiments, which have the mentioned features, to the design of a switching device which is known, for example, from DE 31 05 117 C2.

[0018] However, the mounting of the auxiliary contact bridge in or on the contact bridge carrier and/or the mounting of the auxiliary fixed contacts in the switching device differs from this known switching device. The auxiliary contact bridge in the switching

device known from DE 31 05 117 C2 can only assume a single stable position, namely pushed by spring force in the direction of the main contact bridge. However, the switching device according to an embodiment of the invention, in accordance with a first alternative, includes two defined stable positions of the auxiliary contact bridge. In this case, the auxiliary contact bridge can be displaced, for example, relative to the contact bridge holder perpendicular to the contact bridge holder and, in particular with the assistance of spring force, can be latched into two different positions on the contact bridge holder.

[0019] However, in accordance with a particularly advantageous embodiment, the auxiliary contact bridge is mounted in or on the contact bridge carrier at a suspension point, which cannot be displaced relative to the contact bridge carrier, in a very simple manner in design terms. In this case, the auxiliary contact bridge must have an intrinsic ability to move at least slightly in order to be able to assume two different stable positions. The auxiliary contact bridge is preferably in the form of a snap-action spring which is mounted approximately centrally on the contact bridge carrier.

[0020] In accordance with a second alternative, the auxiliary contact bridge is of rigid design and is mounted in the contact bridge carrier such that it cannot be displaced. However, the auxiliary fixed contact, preferably two auxiliary fixed contacts arranged symmetrically with respect to the contact bridge carrier, is formed in a resilient manner with two possible stable positions. With this embodiment, the auxiliary fixed contact is advantageously in the form of a snap-action spring. However, an intrinsically rigid auxiliary fixed contact may also be provided which can assume two stable positions owing to the fact

that it is mounted in the housing of the switching device such that it can move, for example be displaced or pivoted.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021] Exemplary embodiments of the invention will be explained in more detail below with reference to a drawings, in which:

Figures 1a to 1d	show schematic illustrations of a first embodiment of an electromechanical switching device during the switch-on process,
Figures 2a to 2d	show schematic illustrations of the electromechanical switching device shown in figures 1a to 1d during the switch-off process,
Figures 3a to 3d	show schematic illustrations of a second embodiment of an electromechanical switching device during the switch-on process, and
Figures 4a to 4d	show schematic illustrations of the electromechanical switching device shown in figures 3a to 3d during the switch-off process.

[0022] Mutually corresponding parts or parts having the same function are identified by the same reference numerals in all of the figures.

DETAILED DESCRIPTION OF THE EXEMPLARY EMBODIMENTS

[0023] Figures 1a to 1d and 2a to 2d show very simplified cross-sectional detail illustrations of an electromechanical switching device 1 in the form of a capacitor contactor in different switching states. The switching device 1 has a main contact 2 having a main contact bridge 3 and main fixed contacts 4 as well as

an auxiliary contact 5 having an auxiliary contact bridge 6 and auxiliary fixed contacts 7. A contact bridge carrier 8 is provided for the purpose of actuating the contact bridges 3, 6.

[0024] The main contact bridge 3 is mounted in the contact bridge carrier 8 such that it can be displaced by means of a compression spring 9. By a load being applied via the compression spring 9, the main contact bridge 3 can assume a single stable position relative to the contact bridge carrier 8, which is also referred to as a slide, namely pushed in the direction of the main fixed contacts 4.

[0025] The auxiliary contact bridge 6, in contrast to the main contact bridge 3, is connected to the contact bridge carrier 8 at a point which is fixed relative to the contact bridge carrier 8, namely at the suspension point 10. The auxiliary contact bridge 6 is in the form of a snap-action spring which can assume two stable positions. In order to change over between these two stable positions of the auxiliary contact bridge 6, firstly, in the illustration below the auxiliary contacts 6, the auxiliary fixed contacts 7 and secondly, in the illustration above the auxiliary contact bridge 6, two stops 11 are provided.

[0026] Figure 1a shows the switching device 1 in the switched-off state. The auxiliary contact bridge 6 is located in the first position. When the switching device 1 is switched on by the contact bridge carrier 8 being displaced, at the bottom in the illustration, initially the auxiliary contact 5 closes (figure 1b).

[0027] In the further course of the contact bridge carrier 8 being actuated, the auxiliary contact bridge 6 temporarily assumes an unstable intermediate position. In this case the auxiliary contact 5 remains

closed. With the auxiliary contact 5 closed, the main contact 2 now also closes (figure 1c). If the contact bridge carrier 8 is displaced further in the direction of the switch-on position as the spring 9 is compressed (figure 1d), also referred to as resilience, the auxiliary contact bridge 6, which is mounted at the suspension point 10 such that it cannot be displaced relative to the contact bridge carrier 8, snaps around, i.e. assumes its second stable position. In this second stable position of the auxiliary contact bridge 6, in the exemplary embodiment illustrated the auxiliary contact 5 is always open irrespective of the position of the contact bridge carrier 8.

[0028] When the switching device 1 is switched on, only the main contact 2 is thus closed. As a deviation from this embodiment, the auxiliary contact 5 may likewise remain closed even when the main contact 2 is closed and may only open during the switch-off process, before the main contact 2, i.e. such that it leads said main contact 2.

[0029] With reference to figures 2a to 2d, the switch-off process of the switching device 1 will be explained below. The state of the switching device shown in figure 2a corresponds to the state shown in figure 1d. If the contact bridge carrier 8 is displaced in the direction of the switch-off position, upwards in the illustration, initially the auxiliary contact 5 opens as long as it was not already open (as in the exemplary embodiment), and then the main contact 2 (figure 2c). The auxiliary contact bridge 6 hits against the stop 11 as the main contact 2 opens and, triggered by the opening movement of the contact bridge carrier 8, snaps back around into the first stable state (figure 2d). However, the auxiliary contact bridge 6 is in this case already lifted so far up from the auxiliary fixed contacts 7 that the auxiliary contact 5 no longer

closes. The auxiliary contact 5 thus remains open throughout the switch-off process in the exemplary embodiment. The switching position shown in figure 2d corresponds to the switching position shown in figure 1a.

[0030] Figures 3a to 3d and 4a to 4d show an alternative design for a switching device 1 which differs from the switching device shown in figures 1a to 2d in terms of the configuration of the auxiliary contact 5. With the switching device shown in figures 3a to 4d, the auxiliary contact bridge 6 is of rigid design, whereas the auxiliary fixed contacts 7 are of resilient design and can assume two stable positions. The auxiliary fixed contacts 7 are in this case clamped at one end in the housing (not shown) of the switching device 1.

[0031] Figures 3a to 3d show the switch-on process of the switching device 1. In their first stable position (figure 3a), the auxiliary fixed contacts 7 are bent slightly towards the auxiliary contact bridge 6 which is arranged above them in the illustration and is rigid and straight. The changeover to the second stable position of the auxiliary fixed contacts 7 (figure 3d) takes place in an analogous manner to the switching process shown in figures 1a to 1d. If the contact bridge carrier 8 is located in the closed final position (figure 3d), the auxiliary contact 5 is open in the exemplary embodiment illustrated. Alternatively, the auxiliary contact 5 could, however, also remain closed.

[0032] The switching position shown in figure 4a, which characterizes the beginning of the switch-off process, corresponds to the switching position shown in figure 3d. During the switch-off process, the stops 11, which are in this case fitted to the contact bridge carrier

8, come into operation. By use of the stops 11, the auxiliary fixed contacts 7 are moved over from their second stable position, in which they are deflected in the direction of the main contact 2 (figure 4a), into their first stable position (figure 4d). The auxiliary contact 5 remains open when the switching device 1 is switched off, analogously to figures 2a to 2d. As a deviation from this, an opening of the auxiliary contact 5 could also only be provided during the switch-off process, but in any case before the opening of the main contact 2. The switching position shown in figure 4d corresponds to the switching position shown in figure 3a.

[0033] Exemplary embodiments being thus described, it will be obvious that the same may be varied in many ways. Such variations are not to be regarded as a departure from the spirit and scope of the present invention, and all such modifications as would be obvious to one skilled in the art are intended to be included within the scope of the following claims.